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Report No. 13-23

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Deployment Experiences and Motor Vehicle Crashes Among U.S. Service Members

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Background: Motor vehicle crashes (MVCs) continue to account for a third of service member fatalities each year. Sociodemographic factors associated with MVCs among service members have been evaluated, but whether deployment-specific experiences during the recent operations are associated with a higher risk of MVCs is unclear.

Purpose: Evaluate if military members with specific deployment experiences are at an increased risk of MVCs, while taking into account several potential confounders.

Methods: Millennium Cohort Study participants who enrolled during 2001–2006 and were on active-duty service were evaluated. The Military Health System Data Repository (MDR) was used to investigate MVC-related injuries occurring 6 months postdeployment in relation to service-related factors, while adjusting for demographic, behavioral, and mental and physical health factors. Analysis conducted in 2012 used Cox proportional hazards modeling.

Results: There were 13,620 deployed personnel included in this study. After adjusting for covariates, deployers with combat experiences (hazard ratio [HR]=1.86, 95% CI=1.33, 2.62) and those with more than one deployment (two deployments, HR=1.93, 95% CI=1.32, 2.83; three or more deployments, HR=2.83, 95% CI=1.71, 4.67) had an increased risk for an MVC within 6 months postdeployment. Enlisted rank and non-Hispanic black race/ethnicity were also associated with increased risk for MVCs.

Conclusion: Experiencing combat during deployment and multiple deployments are both strong predictors for MVCs within 6 months of returning home among U.S. military members. These data provide critical information for targeting prevention strategies to decrease MVCs among personnel postdeployment.

(Am J Prev Med 2014;46(4):350–358) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

Introduction

Motor vehicle crashes (MVCs) are a leading cause of morbidity and mortality among U.S. service members.^{1–3} Although rates of motor vehicle fatalities have fallen among both military personnel and civilians over the last several decades,³ MVCs continue to account for almost a third of U.S. military member fatalities each year.^{1,4} Among active duty service members, the rate of MVC-related deaths was 20.4 per 100,000 person-years,³ compared with 14.5 per 100,000 person-years for civilians in 1999–2010 (webappa.cdc.

gov/sasweb/ncipc/mortrate10_us.html). Additionally, MVCs are one of the leading causes of preventable injuries among military personnel.⁵

Sociodemographic factors associated with MVCs among military members have been evaluated,^{2,6–8} but whether specific deployment experiences of the operations in Iraq and Afghanistan are associated with a heightened risk of postdeployment MVCs requires further investigation. Utilizing insurance claims data, a recent report showed that within 6 months following deployment, military personnel had a 13% increase in at-fault MVCs.⁹ However, this study did not adjust for behavioral and health factors and specific in-theater experiences such as combat. A United Kingdom (UK) study found that deployment to Iraq; having a combat role within the unit; and exposure to traumatic events were associated with increased postdeployment risky driving behaviors (i.e., not wearing a seat belt and/or

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0749-3797/\$36.00

<http://dx.doi.org/10.1016/j.amepre.2013.11.015>

speeding), but MVCs were not specifically examined.¹⁰ In civilian populations, high levels of job stress are associated with MVCs,¹¹ and these stressors may be markers for fatigue and distraction, which may also apply to post-deployment military populations. Research has also suggested that traumatic brain injury (TBI) and post-traumatic stress disorder (PTSD) acquired as a result of war-related trauma may impair driving abilities, and that those returning from recent military operations may have a “battle” mindset associated with evasive driving behaviors, although little formal research in this area exists.¹²

Prior research examining veterans of the Vietnam and Persian Gulf wars showed that MVC-related deaths sharply increased after deployments, but additional data regarding the recent operations in Iraq and Afghanistan are needed, given the markedly different in-theater experiences during these conflicts.^{4,7,8,13–15} Therefore, the present study linked data from the Millennium Cohort with the MDR to investigate factors associated with MVC-related injuries within 6 months postdeployment to the recent operations.

Methods

Study Population

The Millennium Cohort Study was launched in 2001 to evaluate if military experiences are associated with adverse health outcomes.^{16,17} Participants were randomly selected from U.S. service members on active duty rosters as of October 2000 and October 2003 and enrolled in phases (referred to as panels) beginning in 2001 and 2004, respectively. Of 77,047 consenting participants enrolled in Panel 1 (2001–2003), 55,021 (71%) completed a first follow-up (2004–2006) and 54,790 (71%) completed a second follow-up questionnaire (2007–2008). There were 31,110 participants enrolled in Panel 2 (2004–2006), of whom 17,152 (55%) completed a first follow-up questionnaire (2007–2008). Further explanation of the methodology of the Millennium Cohort Study has been published elsewhere.¹⁷

Analyses were restricted to Panels 1 and 2 participants who completed a baseline and at least one follow-up questionnaire, were on active-duty status, and were not separated from the military. Because the objective was evaluating postdeployment MVCs, the study population was restricted to those who deployed between baseline and the date of MVC, last completed survey, or military separation. Excluded were those with a history of an MVC prior to baseline or deployment (because medical codes could not differentiate remote versus recent injury or whether medical encounters were related to the same MVC); MVC more than 6 months following deployment; or missing covariate data. The 6-month time frame was chosen based on recent findings of an increase in MVCs among returning deployers 6 months postdeployment.⁹

Data Sources and Definitions

MVCs were assessed using data from the Military Health System Data Repository (MDR), which contains inpatient and outpatient

medical billing records for active-duty personnel between October 1, 1998, and December 31, 2008. The *International Classification of Diseases, 9th Revision* (ICD-9) External Causes of Injury codes (E codes) were used to identify members who sought treatment for either traffic (E810–E819) or non-traffic-related (E820–E825) MVCs.^{18,19} A fourth digit is required for these codes, which identifies the injured person. To examine treatment sought specifically for MVCs, pedestrian-related injuries were excluded from the codes (E810–E825 [.7]). For example, codes E810.1–E810.6 and E810.8–E810.9 were included, whereas E810.7 was excluded. At-fault status was not provided in the E codes. MVCs evaluated were those that occurred after baseline survey date, within 6 months following a deployment, and prior to the last completed survey or date of military separation, whichever occurred first. If multiple MVC E codes were present, only the first date was used due to uncertainty of whether separate E codes were related to the same or different MVC.

Deployment data were obtained from the Defense Manpower Data Center (DMDC), which contains in- and out-of-theater dates for those deployed in support of the operations in Iraq and Afghanistan. Personnel were categorized as deployers if they had completed a deployment between the baseline survey date and date of MVC occurrence, last completed survey, or military separation. Individuals were classified as having combat experience if an affirmative self-report to personally witnessing any of the following five items was provided during a time frame concurrent with a deployment cycle: personally witnessing death due to war; physical abuse; dead/decomposing bodies; maimed soldiers/civilians; or prisoners of war, or refugees. Length of deployment was calculated as cumulative days deployed, beginning with first deployment occurring after the baseline survey date through the last complete deployment occurring before the date of MVC occurrence, last completed survey, or military separation. Number of deployments was determined by counting the total complete deployments during the same time period. With the exception of combat experiences, the deployment characteristic variables were held constant.

Demographic and military-specific data were obtained from the DMDC. These data include sex, birth year, education, race/ethnicity, marital status, pay grade, service component, service branch, occupation, and date of military separation. Except for military separation status, demographics and military characteristics were fixed at baseline.

Health characteristics were assessed using survey data. Physical health conditions included hearing loss, an aggregate physical health symptoms variable, and hours of sleep. Hearing loss was assessed by response to whether a doctor or other health professional had ever told a participant they have hearing loss/tinnitus. A positive screen for the aggregate physical health symptoms covariate was based on endorsement of either of the following items: persistent or recurring problems with confusion, unusual fatigue, and forgetfulness²⁰ or being bothered by fainting spells and headaches, from the Patient Health Questionnaire (PHQ).^{21–23} Hours of sleep was included based on the question “Over that past month, how many hours of sleep did you get in an average 24-hour period?” An aggregate mental health symptoms dichotomous covariate (yes/no) was created including screening positive for major depression or panic or anxiety (using standardized scoring algorithms on the PHQ^{21–23}); medication use for anxiety, stress, or depression; or screening positive for PTSD

(PTSD Checklist–Civilian Version^{22,24–30} using the sensitive criteria defined by the *Diagnostic and Statistical Manual of Mental Disorders, 4th edition*).²⁴ Behavioral factors included problem drinking, assessed from the PHQ based on the standardized algorithm.²³ Using self-reported data on lifetime smoking of at least 100 cigarettes, a successful attempt to quit smoking, and cigarette use in the past year, participants were classified as never smokers, past smokers, or current smokers. Physical, mental, and behavioral health characteristics were time dependent in these analyses, with the exception of hearing loss and physical health symptoms, which were fixed at baseline due to violation of the proportionality assumption.

Statistical Analyses

Unadjusted descriptive statistics were performed to compare demographic, military, and behavioral characteristics by MVC occurrence among active-duty members. Preliminary analyses were conducted to assess multicollinearity (variance inflation factor [VIF] cutoff >4) and proportionality of all time-dependent covariates. Potential confounders were evaluated if they changed the measures of association by more than 10%.³¹ Cox's proportional hazards modeling was performed to investigate univariate and multivariable associations (both adjusted for person time) among MVC occurrence and deployment experience, physical and mental health, behavioral characteristics, and other covariates, which were described using hazard ratios (HRs) and 95% confidence intervals (CIs). For the primary analysis, an event was an MVC occurrence and a nonevent was no MVC occurrence during the first 6 months postdeployment. The person-days for each participant were calculated from the date of baseline survey completion to the date of MVC, last completed survey, or military separation, whichever occurred first. A secondary analysis assessed whether time between returning from deployment and MVC occurrence was an important factor. To explore this further, those with an MVC within the study time frame but longer than 6 months postdeployment were added into the study population, and the analysis followed the same procedure as the primary model. Data management and analyses were performed in 2012 using SAS software, version 9.3 (SAS Institute, Inc., Cary NC).

Results

Of 13,620 deployed participants, 6,800 (50%) reported combat experiences, and 107 (0.8%) had an MVC within 6 months following deployment (Table 1); of these, 0.7% were traffic related (E810–E819) and 0.1% were non-traffic related (E820–E825). The mean baseline age was 28.99 years (SD=7.10) for those with an MVC 6 months postdeployment and 30.84 years (SD=6.94) for those with no MVC. The mean time between returning from deployment and MVC occurrence was 3.07 months (SD=1.65, minimum=0.03, median=3.17, maximum=5.93) (data not shown).

In the univariate analyses adjusted for person time (data not shown), service members with an MVC within 6 months postdeployment were significantly more likely

Table 1. Baseline characteristics of study participants by MVC status 6 months after returning from deployment (N=13,620)

Characteristics	Motor vehicle crash			
	No n=13,513		Yes n=107	
	n	(%) ^a	n	(%) ^a
Combat experiences^{***}				
No	6,767	(50.1)	53	(49.5)
Yes	6,746	(49.9)	54	(50.5)
Cumulative days deployed[*]				
1–90	1,310	(9.7)	5	(4.7)
91–180	3,659	(27.1)	23	(21.5)
181–365	5,619	(41.6)	48	(44.9)
> 365	2,925	(21.7)	31	(29.0)
Number of deployments^{***}				
1	9,388	(69.5)	59	(55.1)
2	2,981	(22.1)	32	(29.9)
≥ 3	1,144	(8.5)	16	(15.0)
Sex[*]				
Male	10,821	(80.1)	77	(72.0)
Female	2,692	(19.9)	30	(28.0)
Birth year^{***}				
Pre-1960	801	(5.9)	6	(5.6)
1960–1969	4,812	(35.6)	29	(27.1)
1970–1979	5,557	(41.1)	39	(36.5)
≥ 1980	2,343	(17.3)	33	(30.8)
Race/ethnicity^{***}				
Non-Hispanic white	8,671	(64.2)	65	(60.8)
Non-Hispanic black	1,612	(11.9)	23	(21.5)
Other	3,230	(23.9)	19	(17.8)
Education^{***}				
Some college or less	10,061	(74.5)	92	(86.0)
Bachelor's or higher degree	3,452	(25.6)	15	(14.0)
Marital status[*]				
Never married	4,911	(36.3)	49	(45.8)
Married	8,069	(59.7)	52	(48.6)
Divorced, other	533	(3.9)	6	(5.6)

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Table 1. Baseline characteristics of study participants by MVC status 6 months after returning from deployment (N=13,620) (continued)

Characteristics	Motor vehicle crash			
	No n=13,513		Yes n=107	
	n	(%) ^a	n	(%) ^a
Military pay grade^{***}				
Enlisted	10,148	(75.1)	96	(89.7)
Officer	3,365	(24.9)	11	(10.3)
Service branch				
Air Force	4,217	(31.2)	35	(32.7)
Army	6,039	(44.7)	52	(48.6)
Marine Corps	861	(6.4)	2	(1.9)
Navy/Coast Guard	2,396	(17.7)	18	(16.8)
Occupation				
Combat specialist	3,386	(25.1)	26	(24.3)
Health care specialist	997	(7.4)	6	(5.6)
Other	9,130	(67.6)	75	(70.1)
Physical health symptoms^{b*}				
No	8,558	(63.3)	62	(57.9)
Yes	4,955	(36.7)	45	(42.1)
Provider-diagnosed hearing loss				
No	12,590	(93.2)	103	(96.3)
Yes	923	(6.8)	4	(3.7)
Mental health symptoms^c				
No	12,561	(93.0)	101	(94.4)
Yes	952	(7.1)	6	(5.6)
Hours of sleep				
<6	2,714	(20.1)	25	(23.4)
6	4,500	(33.3)	31	(29.0)
7	3,470	(25.7)	26	(24.3)
8	2,158	(16.0)	16	(15.0)
>8	671	(5.0)	9	(8.4)
Problem drinking^{d*}				
No	12,044	(89.1)	95	(88.8)
Yes	1,469	(10.9)	12	(11.2)
Smoking status				
Nonsmoker	7,982	(59.1)	64	(59.8)

(continued)

Table 1. (continued)

Characteristics	Motor vehicle crash			
	No n=13,513		Yes n=107	
	n	(%) ^a	n	(%) ^a
Past smoker	2,919	(21.6)	26	(24.3)
Current smoker	2,612	(19.3)	17	(15.9)
Panel^{***}				
1	10,874	(80.5)	74	(69.2)
2	2,639	(19.5)	33	(30.8)

^aSome percentages do not sum to 100 due to rounding^bPhysical health symptoms included persistent or recurring problems with unusual fatigue, forgetfulness, or confusion; and were bothered a little or a lot by headaches, or fainting spells^cMental health symptoms included major depression, panic, or anxiety; post-traumatic stress disorder; and medication use for anxiety, depression, or stress^dProblem drinking was measured using the Patient Health Questionnaire* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

to report combat experiences, have more than one deployment, and be deployed for more than 365 cumulative days compared with those without an MVC ($p < 0.05$). In addition, those with an MVC were more likely female, born in 1980 or later, non-Hispanic black, less educated, not married, enlisted rank, enrolled in Panel 2, and to screen positive for baseline physical health symptoms and problem drinking ($p < 0.05$).

Interactions were a priori assessed among combat experiences and panel, combat experiences and sex, and problem drinking and age, none of which were significant ($p > 0.10$). None of the deployment variables were collinear ($VIF < 4$); hence, they were maintained in the same adjusted models. In the fully adjusted multivariable model, deployers with combat experiences were significantly more likely to have an MVC within 6 months postdeployment compared with those without combat experiences (Table 2). Additionally, this model showed those deployed multiple times had a higher risk of MVC occurrence 6 months postdeployment than those deployed once. No significant association was found for cumulative days deployed. Participants from Panel 2 (versus Panel 1) and non-Hispanic black participants (versus white) were more likely to have an MVC 6 months postdeployment, whereas military officers and Marines had a lower risk.

There were 13,804 participants included in the secondary analysis for an MVC occurring any time postdeployment (Table 3). This included 291 members with an

Table 2. Adjusted associations of MVCs 6 months after returning from deployment, active-duty Millennium Cohort participants (N=13,620)

Characteristics	HR (95% CI)
Deployed with combat experiences	
No	ref
Yes	1.86 (1.33, 2.62)
Number of deployments	
1	ref
2	1.93 (1.32, 2.83)
≥ 3	2.83 (1.71, 4.67)
Cumulative days deployed	
1–90	ref
91–180	1.31 (0.63, 2.76)
181–365	1.23 (0.61, 2.49)
> 365	1.22 (0.58, 2.58)
Sex	
Male	ref
Female	1.22 (0.84, 1.78)
Birth year	
Pre-1960	ref
1960–1969	0.53 (0.28, 1.04)
1970–1979	0.51 (0.26, 1.01)
≥ 1980	0.78 (0.33, 1.84)
Race/ethnicity	
Non-Hispanic white	ref
Non-Hispanic black	1.73 (1.16, 2.58)
Other	0.88 (0.56, 1.38)
Education	
Some college or less	ref
Bachelor's or higher degree	1.45 (0.74, 2.86)
Marital status	
Never married	ref
Married	0.93 (0.64, 1.35)
Divorced, other	1.40 (0.69, 2.86)
Military pay grade	
Enlisted	ref
Officer	0.32 (0.15, 0.70)
Service branch	
Air Force	0.82 (0.55, 1.23)

(continued)

Table 2. (continued)

Characteristics	HR (95% CI)
Army	ref
Marine Corps	0.24 (0.08, 0.76)
Navy/Coast Guard	0.97 (0.62, 1.52)
Occupation	
Combat specialist	1.12 (0.77, 1.64)
Health care specialist	0.55 (0.27, 1.14)
Other	ref
Physical health symptoms^a	
No	ref
Yes	1.19 (0.87, 1.63)
Provider-diagnosed hearing loss^b	
No	ref
Yes	0.51 (0.22, 1.17)
Mental health symptoms^c	
No	ref
Yes	0.98 (0.56, 1.71)
Hours of sleep	
< 6	0.94 (0.59, 1.48)
6	0.84 (0.56, 1.27)
7	ref
8	0.81 (0.49, 1.34)
> 8	1.26 (0.67, 2.38)
Problem drinking^d	
No	ref
Yes	1.57 (0.97, 2.54)
Smoking status	
Nonsmoker	ref
Past smoker	1.12 (0.78, 1.60)
Current smoker	0.63 (0.40, 1.00)
Panel	
1	ref
2	1.92 (1.09, 3.39)

^aPhysical health symptoms were measured at baseline and included persistent or recurring problems with unusual fatigue, forgetfulness, or confusion; and were bothered a little or a lot by headaches or fainting spells.

^bProvider diagnosis of hearing loss was measured at baseline.

^cMental health symptoms included major depression, panic, or anxiety; post-traumatic stress disorder; and medication use for anxiety, depression, or stress.

^dProblem drinking was measured using the Patient Health Questionnaire. CI, confidence interval; HR, hazard ratio.

Table 3. Adjusted associations of MVCs any time following deployment, active-duty millennium cohort participants (N=13,804)

Characteristics ^a	HR (95% CI)
Combat experiences	
No	ref
Yes	1.06 (0.79, 1.42)
Number of deployments	
1	ref
2	1.28 (0.94, 1.74)
≥3	1.64 (1.06, 2.54)
Cumulative days deployed	
1–90	ref
91–180	0.83 (0.54, 1.28)
181–365	0.71 (0.47, 1.08)
>365	0.57 (0.35, 0.92)

^aModel adjusted for person time and the following variables: sex, birth year, race/ethnicity, education, marital status, military pay grade, service branch, occupation, physical health symptoms, provider-diagnosed hearing loss, mental health symptoms, hours of sleep, problem drinking, smoking status, and enrollment panel
CI, confidence interval; HR, hazard ratio.

MVC and a mean time of 13.64 months (SD=11.89, minimum=0.03, median=10.00, maximum=59.77) between returning from deployment and MVC occurrence. The adjusted results showed a nonsignificant association between combat experiences and MVCs ($p=0.71$). Personnel who deployed three or more times were significantly more likely to have an MVC post-deployment. Those deployed for more than 365 days, however, had a significantly lower rate of MVC occurrence compared with those deployed for 90 days or less.

Discussion

This study prospectively investigated whether specific deployment-related experiences during the recent operations in Iraq and Afghanistan were associated with postdeployment MVC-related injuries, while adjusting for important confounders. Findings revealed that combat experiences and deploying multiple times to the recent conflicts were significantly associated with an increased risk for MVCs occurring shortly after returning from deployment. These data provide critical information for targeting prevention strategies to decrease MVCs among military personnel postdeployment.

The significantly elevated risk of MVCs within the first 6 months postdeployment among those reporting

combat experiences may be multifactorial. Those with these wartime experiences may engage in postdeployment risky driving behaviors^{6,7,9} in order to re-create the intense emotions felt during combat. Additionally, those who are inherent risk takers may be more likely to engage in combat experiences in theater.³² Although this study did not collect data on risky behaviors, other studies have found that exposure to traumatic events during the deployment and having a combat role were associated with not wearing a seat belt and with speeding after deployment,^{6,10} both of which can be associated with MVC-related injuries. Further, personnel may acclimate to not wearing seat belts during deployments³³ because of the potential for impeding exit from vehicles and discharging weapons. Combat deployers may also have a sense of lack of control regarding life events and futility of safety measures after exposure to sporadic explosions, combat fire, and deaths during deployment. Finally, driving skills may change during deployment such that potentially lifesaving behaviors, such as speeding, not stopping at intersections, and being anxious while driving (“battle” mindset), may linger into risky driving upon returning home.^{9,12}

Some studies have suggested that TBI and PTSD may impair driving abilities, either by direct effects or associated coping behaviors (e.g., alcohol use).^{10,32} The present study did not find an association among a variety of physical health symptoms (e.g., hearing loss, headache, confusion) and MVCs. Further, using validated instruments to detect underlying mental health symptoms, we found no associations with either the presence of mental health symptoms or the severity of scores (data not shown). The findings that combat experiences are associated with MVCs after adjusting for these comorbidities suggest that physical or mental health symptoms may not be the primary contributors to this association.

In addition to combat experiences, there was a dose-escalating relationship with the number of prior deployments and MVCs. Multiple deployments may instill greater levels of risky driving behaviors that accumulate over time. Although only statistically significant for those deployed three or more times, this relationship was supported by the secondary analysis. The current study did not detect a significant relationship among cumulative days deployed and MVCs. The reason that multiple deployments were significant versus cumulative deployment length may be due to deployers with multiple tours returning home more frequently, giving them more of an opportunity to experience the outcome. Also, more frequent deployments may not always reflect a longer cumulative deployment because several short deployments may not equate to the time associated with one or two long deployments. Moreover, those in special

operations units may deploy for shorter periods while experiencing higher-intensity combat than those on longer deployments.

The secondary examination of all postdeployment MVCs, regardless of timing, found most of the deployment-related associations were no longer present. It has been shown that the time period immediately following returning home and MVC occurrence is critical.⁹ These data suggest that a critical “window of time” may exist for preventing MVCs among recent deployers, which advocates for implementing intervention strategies early in the transition home. Because cumulative days of deployment appeared protective in the subanalysis, these results should be interpreted with some caution, and further studies to validate these results in a larger sample are needed.

Other factors associated with MVC-related injuries included black race/ethnicity and enlisted rank, consistent with a previous study.³⁴ Although a reduced risk for MVCs was observed for Marine Corps compared with Army personnel, this finding should be interpreted with caution because only two injuries occurred among Marines, and this group may be less likely to seek care because of fear of stigma.²⁷ No association was observed between combat specialty and MVC; however, this occupational code does not necessarily indicate actual combat experience. Finally, the elevated risk for MVCs among personnel enrolled in Panel 2 may be related to the larger proportion of younger participants in this panel or due to other unmeasured factors, although this is not statistically significant.

This study has several limitations. It was restricted to active-duty, nonseparated personnel because the MDR does not consistently capture diagnoses (ICD-9 codes) of military reservists, National Guardsmen, and separated personnel, who may receive care outside the military health care system. The MDR also does not consistently capture ICD-9 codes for personnel during deployment; thus, analyses were restricted to deployers so that all participants were subject to this same limitation. As a result, comparing the risk for MVCs between deployers and nondeployers was not feasible. MVCs in this study were restricted to those involved in seeking care for an MVC-related injury; hence events not resulting in medical care were not captured. However, MVCs resulting in a medical care visit have important implications regarding health care costs and force readiness. The Millennium Cohort does not include questions regarding seat belt use, speeding, alcohol use while driving, or other risk-taking behaviors, so this study was unable to account for risky driving behaviors. The study population consisted of a sample of responders to the Cohort and may not be representative of all military deployers; however,

investigations of potential biases in the Cohort have found that the members are representative of the military, reliably report health and military data, and are not influenced to participate by poor health prior to enrollment.^{17,35–44} Additionally, the data used from the Cohort are self-reported, which may be subject to recall and reporting biases. Lastly, the questions used for defining combat experiences were not specific to deployment but occurred within the deployment time frame.

In summary, this is the first study to prospectively examine specific deployment characteristics in relation to MVC-related injuries in a large military cohort, while adjusting for several potential confounders. Service members returning home from deployments to the recent conflicts in Iraq and Afghanistan face many challenges, including the risk of preventable injuries such as those associated with MVCs. This study found that deployers with combat experience and multiple deployments had a significantly increased risk for MVCs occurring within 6 months after returning home. These data provide critical information regarding at-risk groups for targeting prevention strategies and suggest that the timing of their implementation should occur before the transition home.

In addition to the authors, the Millennium Cohort Study Team includes Melissa Bagnell, MPH; James Davies; Raechel DelRosario, MPH; Melissa Frasco, PhD; Nisara Granado, MPH, PhD; Dean Grande; Gia Gumbs, MPH; Jaime Horton, MPH; Andrea Ippolito; Cynthia LeardMann, MPH; William Lee; Michelle Linfesty; Gordon Lynch; Jill MacDougal; Hope McMaster, PhD; Sheila Medina-Torne; Roy Nesbitt, MA; Christopher Phillips, MD, MPH; Teresa Powell, MS; Toni Rush, MPH; Kari Sausedo, MA; Emma Schaller; Amber Seelig, MPH; Beverly Sheppard; Donald Slymen, PhD; Katherine Snell; Steven Speigle; Daniel Trone, PhD; Jennifer Walstrom; John Wesner; Martin White, MPH; James Whitmer; and Charlene Wong, MPH, from the Deployment Health Research Department, Naval Health Research Center, San Diego, California. The authors also thank the professionals from the U.S. Army Medical Research and Materiel Command, especially those from the Military Operational Medicine Research Program, Fort Detrick, Maryland; Scott L. Seggerman from the Management Information Division, Defense Manpower Data Center, Monterey, California; and the Millennium Cohort Study participants.

This work represents report 13-23, supported by the Department of Defense, under work unit no. 60002. The Millennium Cohort Study is funded through the Military Operational Medicine Research Program of the U.S. Army Medical Research and Materiel Command, Fort Detrick MA. The views expressed in this article are those of the authors and

do not reflect the official policy or position of the Department of the Navy, Department of the Army, Department of the Air Force, Department of Defense, Department of Veterans Affairs, or the U.S. Government. Additionally, the funding organizations had no role in the design and conduct of the study; collection, analysis, or preparation of data; or preparation, review, or approval of the manuscript. This research has been conducted in compliance with all applicable federal regulations governing the protection of human subjects in research (Protocol NHRC.2000.0007). Approved for public release; distribution is unlimited.

No financial disclosures were reported by the authors of this paper.

References

- Krahl PL, Jankosky CJ, Thomas RJ, Hooper TI. Systematic review of military motor vehicle crash-related injuries. *Am J Prev Med* 2010;38(1S):S189–S196.
- Krull AR, Jones BH, Dellinger AM, Yore MM, Amoroso PJ. Motor vehicle fatalities among men in the U.S. Army from 1980 to 1997. *Mil Med* 2004;169(11):926–31.
- Armed Forces Health Surveillance Center. Motorcycle and other vehicle accident-related deaths, U.S. Armed Forces, 1999–2010. *Med Surveill Monthly Rep* 2011;18(3):2–5.
- Kang HK, Bullman TA. Mortality among US veterans of the Persian Gulf War: 7-year follow-up. *Am J Epidemiol* 2001;154(5):399–405.
- Jones BH, Hansen BC. An armed forces epidemiological board evaluation of injuries in the military. *Am J Prev Med* 2000;18(3S):14–25.
- Bell NS, Amoroso PJ, Yore MM, Smith GS, Jones BH. Self-reported risk-taking behaviors and hospitalization for motor vehicle injury among active duty army personnel. *Am J Prev Med* 2000;18(3S):85–95.
- Hooper TI, Debakey SF, Bellis KS, et al. Understanding the effect of deployment on the risk of fatal motor vehicle crashes: a nested case-control study of fatalities in Gulf War era veterans, 1991–1995. *Accid Anal Prev* 2006;38(3):518–25.
- Lincoln AE, Hooper TI, Kang HK, Debakey SF, Cowan DN, Gackstetter GD. Motor vehicle fatalities among Gulf War era veterans: characteristics, mechanisms, and circumstances. *Traffic Inj Prev* 2006;7(1):31–7.
- United Services Automobile Association. Returning warriors driving safety report 2012. content.usaa.com/mcontent/static_assets/Media/Returning_Warriors_report_summary.pdf.
- Fear NT, Iversen AC, Chatterjee A, et al. Risky driving among regular armed forces personnel from the United Kingdom. *Am J Prev Med* 2008;35(3):230–6.
- Norris FH, Matthews BA, Riad JK. Characterological, situational, and behavioral risk factors for motor vehicle accidents: a prospective examination. *Accid Anal Prev* 2000;32(4):505–15.
- Lew HL, Amick MM, Kraft M, Stein MB, Cifu DX. Potential driving issues in combat returnees. *NeuroRehabilitation* 2010;26(3):271–8.
- Bullman TA, Kang HK, Watanabe KK. Proportionate mortality among US Army Vietnam veterans who served in military region I. *Am J Epidemiol* 1990;132(4):670–4.
- Centers for Disease Control Vietnam Experience Study. Postservice mortality among Vietnam veterans. *JAMA* 1987;257(6):790–5.
- Watanabe KK, Kang HK. Mortality patterns among Vietnam veterans: a 24-year retrospective analysis. *J Occup Environ Med* 1996;38(3):272–8.
- Gray GC, Chesbrough KB, Ryan MA, et al. The Millennium Cohort Study: a 21-year prospective cohort study of 140,000 military personnel. *Mil Med* 2002;167(6):483–8.
- Ryan MA, Smith TC, Smith B, et al. Millennium Cohort: enrollment begins a 21-year contribution to understanding the impact of military service. *J Clin Epidemiol* 2007;60(2):181–91.
- CDC. Recommended framework of E-code groupings for presenting injury mortality and morbidity data. 2011; www.cdc.gov/injury/wisqars/ecode_matrix.html.
- Orsay EM, Doan-Wiggins L, Lewis R, Lucke R, RamaKrishnan V. The impaired driver: hospital and police detection of alcohol and other drugs of abuse in motor vehicle crashes. *Ann Emerg Med* 1994;24(1):51–5.
- Gray GC, Reed RJ, Kaiser KS, Smith TC, Gastanaga VM. Self-reported symptoms and medical conditions among 11,868 Gulf War-era veterans: the Seabee Health Study. *Am J Epidemiol* 2002;155(11):1033–44.
- Spitzer RL, Kroenke KS, Williams JBW. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire. *JAMA* 1999;282(18):1737–44.
- Spitzer RL, Williams JBW, Kroenke KS, Hornyak R, McMurray J, for the Patient Health Questionnaire Obstetrics-Gynecology Study Group. Validity and utility of the PRIME-MD patient health questionnaire in assessment of 3000 obstetric-gynecologic patients: the PRIME-MD Patient Health Questionnaire Obstetrics-Gynecology Study. *Am J Obstet Gynecol* 2000;183(3):759–69.
- Spitzer RL, Williams JBW, Kroenke KS, et al. Utility of a new procedure for diagnosing mental disorders in primary care. The PRIME-MD 1000 study. *JAMA* 1994;272(22):1749–56.
- American Psychiatric Association. Diagnostic and statistical manual of mental disorders, 4th ed. (DSM-IV). Washington DC: American Psychiatric Association, 1994. .
- Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA. Psychometric properties of the PTSD Checklist (PCL). *Behav Res Ther* 1996;34(8):669–73.
- Brewin CR. Systematic review of screening instruments for adults at risk of PTSD. *J Trauma Stress* 2005;18(1):53–62.
- Hoge CW, Castro CA, Messer SC, McGurk D, Cotting DI, Koffman RL. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *N Engl J Med* 2004;351(1):13–22.
- Smith TC, Ryan MA, Wingard DL, Slymen DJ, Sallis JF, Kritz-Silverstein D. New onset and persistent symptoms of post-traumatic stress disorder self reported after deployment and combat exposures: prospective population based US military cohort study. *BMJ* 2008;336(7640):366–71.
- Weathers FW, Herman DS, Huska JA, Keane TM. The PTSD Checklist (PCL): reliability, validity, and diagnostic utility. Paper presented at the annual meeting of International Society for Traumatic Stress Studies 1993; San Antonio, TX.
- Wright KM, Huffman AH, Adler AB, Castro CA. Psychological screening program overview. *Mil Med* 2002;167(10):853–61.
- Maldonado G, Greenland S. Simulation study of confounder-selection strategies. *Am J Epidemiol* 1993;138(11):923–36.
- Bell NS, Amoroso PJ, Wegman DH, Senior L. Proposed explanations for excess injury among veterans of the Persian Gulf War and a call for greater attention from policymakers and researchers. *Inj Prev* 2001;7(1):4–9.
- Okpala NC, Ward NJ, Bhullar A. Seatbelt use among military personnel during operational deployment. *Mil Med* 2007;172(12):1231–3.
- Hooper TI, DeBakey SF, Pearse L, Pratt S, Hoffman KJ. The use of electronic pharmacy data to investigate prescribed medications and fatal motor vehicle crashes in a military population, 2002–2006. *Accid Anal Prev* 2010;42(1):261–8.
- Chretien JP, Chu LK, Smith TC, Smith B, Ryan MA. Demographic and occupational predictors of early response to a mailed invitation to

- enroll in a longitudinal health study. *BMC Med Res Methodol* 2007;7:6–15.
36. LeardMann CA, Smith B, Smith TC, Wells TS, Ryan MA, for the Millennium Cohort Study Team. Smallpox vaccination: comparison of self-reported and electronic vaccine records in the Millennium Cohort Study. *Hum Vaccin* 2007;3(6):245–51.
37. Riddle JR, Smith TC, Smith B, et al. Millennium Cohort: the 2001–2003 baseline prevalence of mental disorders in the U.S. military. *J Clin Epidemiol* 2007;60(2):192–201.
38. Smith B, Leard CA, Smith TC, Reed RJ, Ryan MA. Anthrax vaccination in the Millennium Cohort: validation and measures of health. *Am J Prev Med* 2007;32(4):347–53.
39. Smith B, Smith TC, Gray GC, Ryan MA. When epidemiology meets the Internet: Web-based surveys in the Millennium Cohort Study. *Am J Epidemiol* 2007;166(11):1345–54.
40. Smith B, Wingard DL, Ryan MA, Macera CA, Patterson TL, Slymen DJ. U.S. military deployment during 2001–2006: comparison of subjective and objective data sources in a large prospective health study. *Ann Epidemiol* 2007;17(12):976–82.
41. Smith TC, Jacobson IG, Smith B, Hooper TI, Ryan MA, for the Millennium Cohort Study Team. The occupational role of women in military service: validation of occupation and prevalence of exposures in the Millennium Cohort Study. *Int J Environ Health Res* 2007;17(4):271–84.
42. Smith TC, Smith B, Jacobson IG, Corbeil TE, Ryan MA, for the Millennium Cohort Study Team. Reliability of standard health assessment instruments in a large, population-based cohort study. *Ann Epidemiol* 2007;17(7):525–32.
43. Smith TC, Zamorski M, Smith B, et al. The physical and mental health of a large military cohort: baseline functional health status of the Millennium Cohort. *BMC Public Health* 2007;7:340–52.
44. Wells TS, Jacobson IG, Smith TC, et al. Prior health care utilization as a potential determinant of enrollment in a 21-year prospective study, the Millennium Cohort Study. *Eur J Epidemiol* 2008;23(2):79–87.

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1. REPORT DATE (DD MM YY) 02 04 13			2. REPORT TYPE Journal		3. DATES COVERED (from – to) 2001–2008	
4. TITLE Deployment Experiences and Motor Vehicle Crashes Among U.S. Service Members					5a. Contract Number: 5b. Grant Number: 5c. Program Element Number: 5d. Project Number: 5e. Task Number: 5f. Work Unit Number: 60002	
6. AUTHORS Kelly A. Woodall, Isabel G. Jacobson, & Nancy F. Crum-Cianflone						
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Commanding Officer Naval Health Research Center 140 Sylvester Rd San Diego, CA 92106-3521						
8. SPONSORING/MONITORING AGENCY NAMES(S) AND ADDRESS(ES) Commanding Officer Naval Medical Research Center 503 Robert Grant Ave Silver Spring, MD 20910-7500 Chief, Bureau of Medicine and Surgery 7700 Arlington Blvd Falls Church, VA 22042					8. PERFORMING ORGANIZATION REPORT NUMBER 13-23	
					10. SPONSOR/MONITOR'S ACRONYM(S) NMRC/BUMED	
					11. SPONSOR/MONITOR'S REPORT NUMBER(s)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.						
13. SUPPLEMENTARY NOTES <u>American journal of Preventive Medicine</u> , 2014, Apr; <u>46</u> (4), 350-8.						
14. ABSTRACT <p>Motor vehicle crashes (MVCs) continue to account for a third of service member fatalities each year. Sociodemographic factors associated with MVCs among service members have been evaluated, but whether deployment-specific experiences during the recent operations are associated with a higher risk of MVCs is unclear. Millennium Cohort Study participants who enrolled during 2001–2006 and were on active-duty service were evaluated. The Military Health System Data Repository was utilized to investigate MVC-related injuries occurring 6 months postdeployment in relation to service-related factors while adjusting for demographic, behavioral, and mental and physical health factors. Cox proportional hazards modeling was used for analysis. A total of 13,620 deployed personnel were included in this study. After adjusting for covariates, deployers with combat experiences ((hazard ratio [HR] = 1.86, 95% confidence interval [CI] = 1.33–2.62) and those with more than one deployment (two deployments, HR = 1.93, 95% CI = 1.32–2.83; three or more deployments, HR = 2.83, 95% CI = 1.71–4.67) had an increased risk for a MVC within 6 months postdeployment. Experiencing combat during deployment and multiple deployments are strong predictors for MVCs within 6 months of returning home among U.S. military members. These data provide critical information for targeting prevention strategies to decrease MVCs among personnel following deployment.</p>						
15. SUBJECT TERMS motor vehicle crashes, military personnel						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UNCL	18. NUMBER OF PAGES 10	18a. NAME OF RESPONSIBLE PERSON Commanding Officer	
a. REPORT UNCL	b. ABSTRACT UNCL	c. THIS PAGE UNCL			18b. TELEPHONE NUMBER (INCLUDING AREA CODE) COMM/DSN: (619) 553-8429	